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A REPORT OF OBSERVED EFFECTS ON ELECTRICAL SYSTEMS OF AIRBORNE CARBON/GRAPHITE FIBERS

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Carbon fibers were first produced nearly a century ago in the search for an incandescent lamp filament. However, after the introduction of tungsten filaments, interests in carbon for lamps declined. More recently the search for new, high-strength, high-stiffness materials has renewed interest in carbon fibers. In the period 1963-1965, it was discovered that very high strength filaments could be obtained by subjecting a precursor fiber to a rigidly controlled tensile stress during high temperature pyrolization. Technically, the term "carbon fiber" applies to fibers which have been pyrolized at temperatures of 1100°C to 1200°C, and the term "graphite fiber" applies to those carbon fibers which have been heat treated at temperatures on the order of 2200°C to 2700°C. In practice, however, the two terms are often used interchangeably to describe the high-stiffness carbon-based fibers.

Individual fibers are about 8μm in diameter and are produced in the form of yarns, each strand containing thousands of individual fibers. The chemical and physical

properties that produce strength and stiffness characteristics also result in very high electrical conductivity for the fiber. The very high temperatures at which fibers are formed insure their virtual indestructability under most conditions.

The singular properties of carbon/graphite fibers become of practical interest when they are translated into a useful form through consolidation with a matrix (binder), into a composite material. Studies based on experience gained from R&D programs and production of advanced composite aerospace structures indicate that utilization of graphite fiber composites in aircraft can add strength and reduce weight and thus provide significant benefits in cost and performance.

In the research that has been carried out on these promising new materials, the release of free carbon/graphite fibers into the environment has been identified as a potential problem.

The composite materials themselves pose no known hazard; the plastics used as binders, or matrix materials, are generally identical to plastics having a long history of safe use in a variety of consumer applications. Nor do the carbon graphite fibers appear to pose a public health hazard. However, if released from the composite materials the fibers can present a hazard to electrical machinery.

The high electrical conductivity of the carbon/graphite fibers is the prime factor in their effects on electrical equipment; however, other properties such as small fiber diameter, generally short length and low density are also important contributing factors. These latter fiber characteristics permit any small movement of air to cause free fibers to become airborne and to be transported over relatively long distances by normal atmospheric motion. Because of their high conductivity, carbon/graphite fibers which settle on or across electrical contacts or circuits can cause effects which could damage equipment or cause it to malfunction. They can cause: (1) resistive loading;

(2) temporary shorts; or (3) electrical arcing.

Industrial plants producing and using free fibers have nearly all experienced malfunctions of electrical and electronic equipment and, in some cases, resultant fires. These industries have found it possible to limit these problems by controlling the fibers in production and by instituting protective measures for electrical equipment and circuits. Such measures include eliminating exposed conductors, covering conductors with conformal coating, or providing fan filters. Similar problems have not been experienced by industries which receive and use the carbon/graphite fibers after they have been "pre-impregnated" with a plastic binder or fully consolidated in the form of a composite.

There are situations in which carbon/graphite fibers can be released from composites. Burning of a composite material followed by mechanical agitation can release a fraction of the carbon/graphite as single fibers or as lint.

Waste disposal by incineration of either industrial

scrap or discarded composite products represents a possible source of free carbon/graphite fibers capable of causing electrical effects. Accidental fires in vehicles (aircraft or automobiles) incorporating significant amounts of carbon/graphite fiber composites are other potential sources of free fibers.

Limited test data indicate that electrical equipment tolerance to free carbon/graphite fiber interference can be characterized in terms of exposure, or (fibers/m^3)sec; electrical interference seems to begin in the exposure range of 10^4 - 10^7 (fibers/m^3) sec.

Research is continuing on assessment of fiber effects, protective techniques, and alternate materials (i.e., non-fiber releasing binders); results will be published as they become available.

It is recommended that all manufacturers and users of carbon/graphite fiber composite materials exercise caution in handling of free fibers. Disposal of carbon/graphite

fiber composites should be limited to controlled land fill.

Requests for further information should be directed to NASA's Office of External Relations.

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15 Supplementary Notes
This document describes a potential hazard to electrical machinery posed by the release of free carbon/graphite fibers into the environment.

16 Abstract

Research on composite materials containing carbon/graphite fibers reveals that the release of free carbon/graphite fibers into the environment presents a potential problem. Such release does not appear to pose a public health problem, but can present a hazard to electrical machinery.

The high electrical conductivity of the carbon/graphite fibers is the prime factor in their effects on electrical equipment; however, other properties such as small fiber diameter, general short length and low density are important contributing factors.

It is recommended that all manufacturers and users of carbon/graphite fiber composite materials exercise caution in handling of free fibers. Disposal of carbon/graphite fiber composites should be limited to controlled land fill.

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